

Rapid Estimation of Blood Sugar Content

A New Method Using Clinitest® Tablets

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THE UTILITY of frequent blood sugar determinations in the management of diabetic acidosis and coma is often impaired because of delay in obtaining reports. Commonly this fundamental measure of the temporarily altered metabolic state is available to the clinician only at intervals varying from 45 minutes to two hours after venesection—too late to be of value except as aid in estimation of the current status by way of hindsight.

A method for the rapid estimation of blood sugar has been developed on the Metabolic Service of the Los Angeles Veterans Administration Hospital which has been found useful as an adjunct to the management of diabetic patients in acidosis. This method makes use of Clinitest® tablets, commonly used for urine testing, and other equipment that is available in any hospital ward laboratory. The method is rapid and simple and adds as little burden as possible to a busy house staff.

METHOD

Test tubes etched with a line at the 5 ml. level, identical with those in common use for the determination of the prothrombin time, are prepared by adding 0.5 ml. of 50 per cent sulfosalicylic acid. The tubes (blood Clinitest tubes) are fitted with rubber stoppers and kept available on the ward for blood sugar estimation.

In performing the test, 4.5 ml. of freshly drawn venous blood is added to the blood Clinitest tube directly from the syringe. This brings the total amount of fluid, blood and sulfosalicylic acid, up to the etched line. The tube is then stoppered, gently inverted three or four times in rapid sequence and then vigorously shaken until no trace of red color remains. Protein precipitation has been found to be complete when the contents are a dull brown in color, the change taking from one to two minutes of vigorous shaking. The tube is then unstoppered and centrifuged for ten to fifteen minutes. Exactly six

• A new, simple method for estimation of the sugar content of the blood, employing Clinitest® tablets such as are used for urine tests, gives quick information in cases of suspected diabetic acidosis.

drops of water is then added to a clean test tube, care being taken to add the drops vertically so that none of the water runs down the side of the tube. To the six drops of water are added nine drops of the protein-free supernatant. Then a Clinitest tablet is added to the resultant mixture and the tube is gently agitated while boiling is taking place. After a wait of a minute or longer the color is compared to the standard Clinitest urine color chart. Correlations of color changes with total content of reducing substances per 100 cc. of blood has been found to be as follows: Trace, 125 mg.; one plus, 125 to 225 mg.; two plus, 225 to 465 mg.; three plus, 465 to 585 mg.; four plus, 585 mg. or more.

It has occasionally been found desirable to subdivide the rather wide two plus range. This is done rather simply by adding five drops of supernatant to ten drops of water and repeating the test. With this modification the following color correlations are found: one plus, 225 to 325 mg. per 100 cc.; two plus, 325 to 465 mg.

Standardization of the method was carried out with water standards prepared by using standard dextrose supplied by the U. S. Bureau of Standards. The ratio of nine drops of supernatant to six of water is the result of a series of trial and error approximations using glucose water standards in the place of supernatant. This dilution was found to produce the most useful range of values with color changes occurring at points chosen to be of value in the management of acidotic patients. Exacting care as to addition of the proper number of drops was found to be essential if results are to be duplicated. The sugar content of a series of blood specimens from diabetic patients was determined both by the method described and by the hospital clinical laboratory using the method of Kingsley and Reinhold.³ Blood sugar values varied from 34 to 672 mg. per 100 cc. and a reasonably close correlation

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TABLE 1.—Comparison of Blood Clinitest Determinations with Plasma-True Glucose

Blood Clinitest Reading	Predicated Range of Values (mg. per 100 cc.)	True Glucose (Kingsley and Reinhold Method ³) (mg. per 100 cc.)
Trace	125 or below	34, 78, 83, 136
One plus	125 to 225	149, 170, 170, 188, 200, 222, 292
Two plus	225 to 465	267, 276, 284, 292, 328, 342, 346, 404, 465
Three plus	465 to 585	346, 353, 445, 448, 506, 540, 584
Four plus	585 or above	610, 672

with the blood Clinitest predictions based on water standards was noted, as shown in Table 1.

DISCUSSION

Many methods to simplify the time-consuming, multiple-step procedures for determining of blood sugar have been devised in an effort to make them useful for bedside or ward use by a clinician caring for a diabetic patient. Without attempting a critical review of the literature, it may be said that none of these methods have come into wide use because of the number of steps involved or the special equipment required. A recent method using glucose oxidase impregnated paper (Tes-Tape®)⁶ was tried by the authors but was considered unsatisfactory because of the variability of color reaction and the need for the preparation of serial dilutions. Leonards⁴ documented the difficulties in using this product for quantitation of urine sugar, and our own observations using both urine and blood tended to confirm Leonards'.

Of particular interest are two recent communications in the British literature describing a method quite similar to the one herein described.^{1,5} With this method a tablet of sulfosalicylic acid eliminates

the need for pre-prepared tubes, and a more dilute solution permits filtration. The range of values is restricted, however, to 200 mg. per 100 cc. or less, thus effectively omitting the range which is most significant in the management of diabetic acidosis unless serial dilutions are used.

We have found it useful to perform a blood sugar estimation in the admitting room when the diagnosis of diabetic acidosis is first suspected. The result then accompanies the patient to the ward, where therapy with insulin and nonglucose-containing fluids may be instituted without delay. The use of nonglucose-containing fluids makes the estimation of the blood sugar an excellent guide as to the efficacy of the insulin dosages employed. Glucose is withheld until a definitive reduction in blood sugar has occurred or until the Clinitest indication of sugar content is one plus (125 to 225 mg. per 100 cc.). The protein-free filtrate is also suitable for the estimation of blood acetone,² and we have found it desirable to perform this determination in association with blood sugar estimation.

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